Mysore J. Agric. Sci., 59 (1) : 47-54 (2025)

Third and Fourth Degree Statistics-Based Genetics of Grain Yield and its Contributing Traits in Grain Amaranth (*Amaranthus* spp.)

T. N. Dhanalakshmi[1], K. Madhusudan[2], S. Ramesh[3], A. Mohan Rao[4], K. M. Srinivas Reddy[5] and S. R. Anand[6]
[1,2,3&4]Department of Genetics and Plant Breeding, [5]Department of Agricultural Entomology, [6]Department of Agronomy, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : dhanugpb@gmail.com

Authors Contribution

T. N. Dhanalakshmi : Conceptualization, data collection and draft manuscript preparation

K. Madhusudan : Guidance and supervision

S. Ramesh ; A. Mohan Rao ; K. M. Srinivas Reddy & S. R. Anand : Provided resource to conduct the experiment, manuscript editing and guidance

Corresponding Author :
T. N. Dhanalakshmi

Received : October 2024
Accepted : November 2024

Abstract

Grain amaranth (*Amaranthus* spp.) is a nutritious crop gaining attention among consumers nowadays. Crop improvement or plant breeding activities in the direction of development of elite cultivars are of present-day concern. To develop such an elite, one's germplasm is the reservoir of all desirable traits. With this intention, the current work has been carried out to dissect the variability of 1880 germplasm collections received from NBPGR New Delhi; Regional station, Phagli, Shimla, Himachal Pradesh, and Regional station, Akola, Maharashtra. All the yield and contributing traits show significant differences statistically and also showed the pathway to select the superior lines. The results showed that the GCV and PCV were comparable for the traits such as, days to 50 per cent flowering and plant height (cm); high for inflorescence length (cm), volume weight of seeds (g/10ml) and grain yield plant^{-1} (g). All the traits exhibited high heritability. Highgenetic advance as per cent of mean was observed for days to 50 per cent flowering, plant height, panicle length, seed weight and grain yield per plant indicating scope for improvement of the traits of interest through hybridization and selections. The accession IC0038057 recorded a higher yield of 45.1 g of grain yield compared to check varieties (Suvarna; 27.52g and KBGA-15; 25.69g). This suggests that there is significant potential for improvement through selection. Additionally, positive skewness and high values of kurtosis were observed for days to 50 per cent flowering, plant height and inflorescence length. This suggests that these traits usually are generally distributed within the population and are likely influenced by complementary gene action.

Keywords : Grain amaranth, Skewness, Kurtosis, Germplasm

Amaranthus, also known as amaranth, is a diverse genus of annual or short-lived perennial plants. Some amaranth species are cultivated as leafy vegetables, pseudo-cereals and ornamental plants. There are over 60 identified species with inflorescences and foliage ranging from purple and crimson to green or gold. Amaranth species are erect or spreading annuals that have a rough or prickly texture. Grain amaranths typically have maroon or scarlet flowers, leaves and stems. Some varieties have green blossoms, while others are more golden. Amaranth, which originated in America, is one of the world's oldest food crops with evidence of domestication date back to 6700 BC. Amaranthus is a genus with over 60 species. Certain varieties are cultivated as leafy vegetables, grains or ornamental plants, whereas others are classified as weeds (Aderibigbe *et al.,* 2022).

Amaranth is commonly grown as a green leafy vegetable in temperate and tropical countries. Although it is also used as a grain, amaranth is more widely used as a pot herb and in some instances supplies a substantial part of the protein, minerals and vitamins in the diet. This wide nature makes it an easy crop to cultivate and domesticate. Grains are the rich house of various nutrients required for a balanced human diet and health (Niranjanamurthy and Arunkumar, 2017; Anand *et al.,* 2020 and Aderibigbe *et al.*, 2022).

So far, majority of the varieties developed in this crop have been developed through choices of assembled material. However, to improve its yield and other vital qualities and promote it as a regular crop, it is critical to understand the variability available for morphological and quality attributes in this crop. In light of this, the present study was conducted to understand the mode of gene action and their distribution in the procured grain amaranth germplasm material.

Material and Methods

One thousand one hundred and eighty-grain amaranth germplasm accessions from NBPGR, New Delhi; Phagli, Regional Station, Shimla, Himachal Pradesh and Regional station, Akola, Maharashtra along with two checks were sown in 20 blocks (paired compact blocks) of each 94 germplasm entries plus two checks (repeated six times each) laid out by adopting an online design experiment developed by ICAR, New Delhi (https://drs.icar.gov.in) with a row length of 1.5 mm Augmented design (Federer, 1961). The seeds of accessions and check varieties were sown uniformly and thinning was done to maintain the spacing of 45cm between the rows and 10cm between the plants in the fields of All India Coordinated Research Network project on Potential crops, University of Agricultural Sciences, GKVK, Bengaluru during 2022 *kharif* season.

Two check varieties *viz.,* Suvarna and KBGA 15 were also used along with the accessions. The two check varieties were developed and released from All India Coordinated Research Network Project on Potential Crops, University of Agricultural Sciences, GKVK, Bengaluru. Suvarna is recognized as a national check in many national trials also. The accessions and check varieties were evaluated for different agro-morphological characters. A basal application of fertilizer in the ratio of 30:40:40 kg NPK ha^{-1} was given to the experimental plot, in addition to a top dressing of 30 kg N ha^{-1} applied 32 days post-sowing. To ensure a healthy crop, recommended agronomic and plant protection techniques were implemented during the growing season.

Five random plants were chosen to record grain yield and attributing variables such as days to 50 per cent flowering, plant height (cm), inflorescence length (cm), grain yield $plant^{-1}$ (g) and volume weight of seeds (g/10ml) (Table 1).

Statistical data analysis : The average values computed on sample plants in each accession and check varieties were subjected to statistical analysis.

Table 1

Procedure for recording grain yield and its contributing traits

Traits	Procedure of measurement
Days to 50% flowering (days)	Number of days taken from the date of sowing to the day on which 50 per cent of the plants in each genotype flowered was recorded
Inflorescence length (cm)	The length of the inflorescence from the base of the spike to the tip was measured, centimetres expressed.
Plant height (cm)	The height of the main stem from the ground level to the initiation of the inflorescence was measured during harvest and expressed in centimeters
Grain yield $plant^{-1}$ (g)	The total quantity of seeds obtained from the threshing of harvested and dried inflorescence in randomly selected five plants was weighed and expressed in grams.
Volume weight of seeds (g/10ml)	The seed weight measured on a volume/weight basis (g/10 ml).

Analysis of Variance (ANOVA)

The (ANOVA) analysis of variance (Federer, 1956) was utilized for separating variability components from overall variability as a result of the augmented design, using 'R' software.

Studies on the Distribution Patterns of Skewness and Kurtosis

Skewness and kurtosis assist us in understanding the relative mean performance and distinctive distribution patterns of the attributes in the investigated material. Skewness refers to the degree of deviation from the symmetrical bell curve or normal distribution. If skewness > 0, the right tail (higher values) of the distribution is longer or fatter than the left tail. This implies that the bulk of the data is concentrated on the left with a few larger values extending to the right. If skewness < 0, the left tail (lower values) is longer or fatter than the right tail. This indicates that most of the data is concentrated on the right with a few smaller values extending to the left and skewness of 0 indicates that the data is perfectly symmetrical, like a normal distribution.

Kurtosis determines the 'tailedness' of a distribution, indicating how much data is in the tails and how sharp or flat the peak is compared to a normal distribution. If kurtosis is greater than three, the distribution has fatter tails and a sharper peak than a normal distribution and this distribution is known as Positive Kurtosis (Leptokurtic). If kurtosis < 3, the distribution has thinner tails and a flatter peak than a normal distribution and is named Negative Kurtosis (Platykurtic) and Zero Kurtosis (Mesokurtic), but if kurtosis = 3, the distribution is equivalent to a normal distribution in terms of tail thickness and peak height.

Results and Discussion

The analysis of variance of 1880 grain amaranth germplasm accessions for grain yield and component characters under study is presented in Table 2. This analysis of variance revealed that the mean sum of squares due to accessions was highly significant for all the studied characters. Significant mean sum of squares due to yield and attributing characters revealed the existence of considerable variability in the material studied for the improvement of various traits.

Descriptive statistics (Table 3) show a mean of 30.72 days 50 per cent blooming with a minimum of 25 and a maximum of 61 days. The average length of the inflorescence was 38.85 cm with lowest and maximum values of 19.86 and 61.34 cm for the same characteristic. The average plant height was 70.46 cm with a range of 20.25 cm to 215.79 cm. Similarly, volume weight of seeds (g/10ml) and grain yield per plant (g) had mean values of 6.59 g and 18.40g with ranges of 2.92g to 9.28g and 6.25g to 40.40g, respectively. The estimates of range and standardized range provide clues about the occurrence of accessions with an extreme expression that varied with the trait.

Table 2

Analysis of variance (ANOVA) for grain yield and its component characters in Grain Amaranth germplasm accessions

Source of variation	Degrees of freedom	Days to 50% flowering	Inflorescence length (cm)	Plant height (cm)	Grain yield plant^{-1} (g)	Volume weight of seeds (g/10ml)
Accessions (ignoring blocks)	1881	37.17 **	71.29 **	2753.12 **	11.24 **	0.55 **
Checks	01	9.03 **	189.00 **	0.14	10.10 *	6.66 **
Accessions	1879	18.41 **	71.27 **	2705.97 **	9.86 **	0.55 **
Accessions *vs.* Check	01	35328.79 **	0.08	94112.44 **	2606.62 **	0.02
Blocks(eliminating Accessions)	19	3.24	7.39	46.53	36.08 **	0.07
Residuals	19	3.24	15.04	56.68	1.72	0.18

*: Significant at 5% level; **: Significant at 1% level

TABLE 3

Descriptive statistics for grain yield and its component characters in Grain Amaranth germplasm accessions

Traits	Mean ± SE	Absolute range		Standardized range	Skewness	Kurtosis
		Minimum value	Maximum value			
Days to 50% flowering	30.72 ± 0.11	25.72	61.20	1.15	2.13 **	9.39 **
Inflorescence length (cm)	38.85 ± 0.20	19.86	61.34	1.07	0.19 **	2.11 **
Plant height (cm)	70.46 ± 1.20	20.25	215.79	2.78	1.41 **	3.33 **
Yield per plant (g)	18.40 ± 0.13	6.25	40.40	1.86	0.19 **	3.00 **
Seed weight (g/10ml)	6.59 ± 0.02	2.92	9.28	0.97	-0.22 **	3.76 **

*: Significant at 5% level**: Significant at 1% level

However, the standardized range per se does not reflect the variability in the expression of all the accessions; these findings are consistent with Sarker *et al.* (2015), Dhangrah *et al.* (2015), Malaghan *et al.* (2018), Adeniji (2018), Vipin *et al.* (2020) and Kumar *et al.* (2021).

The estimates of GCV and PCV reflects average inter-accession differences and are more useful tools to understand the variability among the germplasm accessions under study. Genetic variability parameters of 1880 germplasm accessions (Table 4) shown for every trait, the phenotypic coefficient of variation (PCV) was greater than the corresponding genotypic coefficient of variation (GCV) and for plant height(cm) and days to 50 per cent flowering trait was on par. High heritability was observed for all the characters under study. Genetic Advance as a per cent of mean was high for all the traits except for volume weight of seeds (g/10ml) which is medium.

Heritability estimates and genetic gain can be used to identify the heritable variance; in the current analysis, heritability was only broadly assessed. Even so, high heritability can be used to increase seed production kg per ha because it indicates a substantial proportion of genetic impacts in the determination of these traits. High heritability in the grain yield plant^{-1} (g) characteristic may be due to a higher contribution from additive genetic components in the inheritance of these traits. According to variability research, direct selection is a more successful method for improving all of the features in amaranth. Similar results also found earlier by Sarker *et al.* (2015) in *Amarathus tricolor* L., Dhangrah *et al.* (2015) in vegetable amaranth, Malaghan *et al.* (2018) in *Amaranthus* spp;

TABLE 4

Genetic variability parameters for grain yield and its component characters in Grain Amaranth germplasm accessions

Traits	Phenotypic coefficient of variation	Genotypic coefficient of variation	heritability (h^2_{BS})	Genetic advance as *per cent* mean
Days to 50% flowering	13.96	12.68	82.42	23.74
Inflorescence length (cm)	21.73	19.30	78.89	35.37
Plant height (cm)	73.82	73.05	97.91	149.11
Grain yield plant^{-1} (g)	17.06	15.50	82.60	29.07
Volume weight of seeds (g/10ml)	11.21	9.12	66.13	15.30

Adeniji (2018) in *A. cruentus*; Vipin *et al.* (2020) in *Solanum lycopersicum* and Kumar *et al.* (2021) in *A. tricolor* L.

Distribution features such as skewness and kurtosis studies reveal information about the distribution pattern of the traits under investigation in the accessions. Skewness is the amount by which a distribution deviates from the symmetrical bell curve or normal distribution. It measures the distribution's asymmetry. Days to 50 per cent flowering, inflorescence length (cm), plant height (cm) and grain yield plant^{-1} (g) showed leptokurtic and positively skewed distribution whereas, volume weight of seeds (g/10ml) showed leptokurtic and negatively skewed distribution. Similar findings were reported by Dhanalakshmi *et al.* (2014) in finger millet and Kanavi *et al.* (2020) in green gram. Skewness and Kurtosis coefficients are displayed using frequency distribution curves (Fig. 1-5) for days

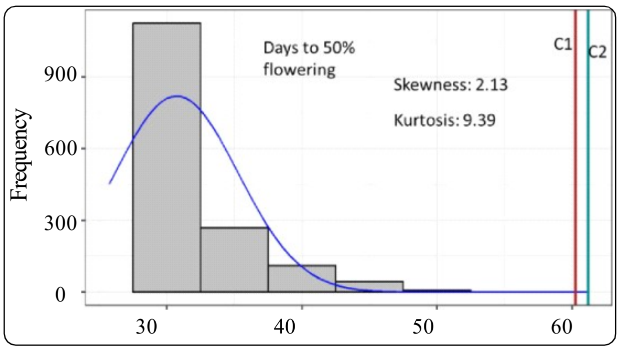

Fig. 1 : Leptokurtic and positively skewed distribution of days to 50% flowering in Grain Amaranth germplasm accessions

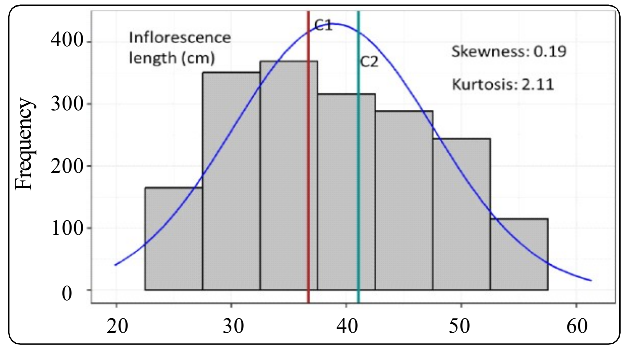

Fig. 2 : Leptokurtic and positively skewed distribution of inflorescence length (cm) in Grain Amaranth germplasm accessions

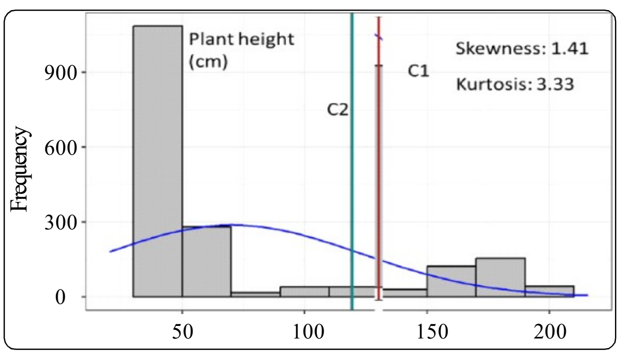

Fig. 3 : Leptokurtic and positvely skewed distribution of plant height (cm) in Grain Amaranth germplasm accessions

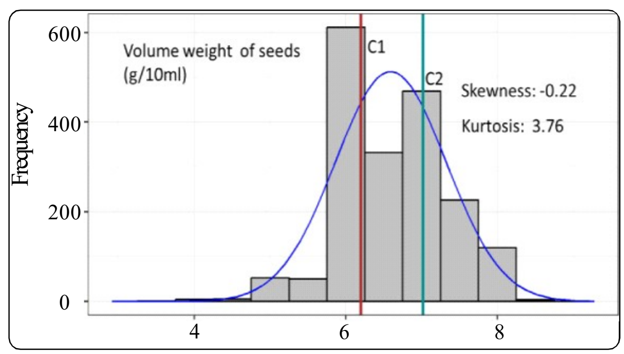

Fig. 4 : Leptokurtic and negatively skewed distribution of volume weight of seeds (g/10ml) in Grain Amaranth germplasm accessions

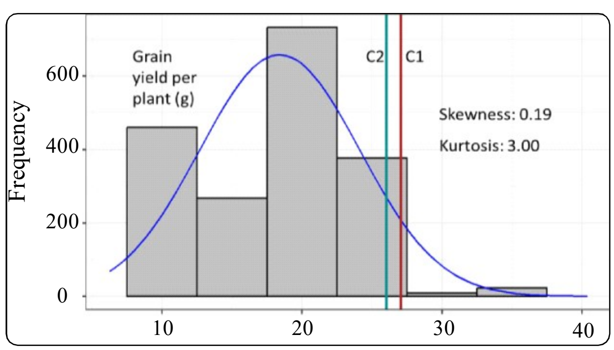

Fig. 5 : Leptokurtic and positvely skewed distribution of grain yield per plant (g) in Grain Amaranth germplasm accessions

to 50 per cent flowering, inflorescence length, plant height, grain yield plant^{-1} and volume weight of seeds (g/10ml).

Coefficients of Skewness and Kurtosis

Skewness and kurtosis are more powerful than first and second-degree statistics which reveal interaction genetic effects (Choo and Reinbergs 1982). The skewed distribution of a trait in general suggests that the trait is under the control of non-additive gene action, especially epitasis and is influenced by environmental variables (Mardia 1970; Pooni *et al.,* 1977; Groeneveld & Meeden 1984; Kimbeng & Bingham 1998; Roy 2000; Kim & White 2004; Blanca *et al.* 2013; Mokkaraj & Geethanjali, 2016 and Cain *et al*., 2017). Skewness, kurtosis, third and fourth-degree statistics, respectively were calculated (Snedecor and Cochran, 1994) better to understand the distribution of quantitative features in the accessions. Genetic expectations of skewness (-3/4 d^2h) show the nature of the trait's genetic regulation (Fisher *et al.,* 1932). The value 'd' reflects additive gene effects, while 'h' denotes dominant gene effects. Kurtosis represents the relative number of genes regulating the phenotypes (Robson, 1956).

The Nature of Genetic Control as Measured by Skewness and Kurtosis Coefficients

A skewed distribution of a trait in general indicates that the trait is under the control of non-additive gene activity, particularly epistasis and is influenced by environmental variables (Pooni *et al.,* 1977; Kimbeng & Bingham, 1998 and Roy, 2000). Positive skewness indicates complementary gene interactions, whereas negative skewness indicates duplicate gene interactions (additive × additive). Genes influencing a skewed distribution are more likely to be dominant, regardless of whether they have an increasing or decreasing effect on the trait. Traits with leptokurtic and platykurtic distributions are determined by fewer and more genes, respectively. Kurtosis is negative or close to zero in the absence of gene interaction and positive in the presence of gene interactions (Pooni *et al.,* 1977; Choo & Reinbergs, 1982 and Kotch *et al.,* 1992). Considering that the number of germplasm accessions evaluated in the present study is large and assuming that the observed variability is comparable to that of F_2 population, inferences on the relative number and nature of genetic control of different traits are discussed (Dhanalakshmi *et al.,* 2014 and Patil *et al.,* 2017).

The inheritance of trait volume weight of seeds appears to be controlled by fewer numbers of dominant genes with the majority of them having increasing effects and duplicate type of gene interaction as indicated by the negatively skewed leptokurtic distribution of the trait. There were a moderate number of genes with equal frequencies of genes having rising and lowering effects on plant height expression with duplicate epistasis. Genetic increase in terms of volume weight of seeds with a negatively skewed distribution will be quick under light selection from the current variability (Roy, 2000).

The leptokurtic and positively skewed distribution indicated the involvement of a relatively small number of segregating genes, with the majority of them having decreasing effects and a dominance-based complementary type of interaction in the inheritance of days to 50 per cent flowering, inflorescence length (cm), plant height (cm) and grain yield plant^{-1} (g). Maximizing genetic gain for characteristics with positively skewed distributions necessitates intensive selection from existing variability (Roy, 2000; Kanavi *et al.,* 2020 and Yankanchi *et al*., 2022). Assuming that dominant genes control the majority of characteristics, developing and identifying superior inbred lines produced from heterotic crossings appears to be a more effective technique for the genetic modification of grain amaranth.

The accessions recorded higher grain yield compared to checks were listed in Table 5. Such knowledge is useful, in developing suitable strategies for developing grain amaranth-dense varieties.

In conclusion, the results of this study indicated significant variability among different grain amaranth genotypes, with high phenotypic and genotypic coefficients of variation recorded for grain yield-related traits such as inflorescence length, plant height, volume weight of seeds (g/10ml) and grain yield plant^{-1}. This shows that the germplasm accessions have a high degree of diversity, implying that there is ample opportunity for improvement through selective breeding. All grain yield and contributing variables were estimated to have substantial heritability and genetic progress as a percentage of the mean. This shows that additive gene activity influences these traits and that direct selection may be used to improve them. Overall, the study's findings emphasize the necessity of understanding the genetics of many features in grain amaranth, as well as gene expression patterns within the population. A greater understanding of these traits could enable us to discover essential characteristics that can be targeted in breeding efforts to increase grain amaranth productivity. The accession IC0038057 recorded a higher yield of 45.1 g of grain yield compared to check varieties can be used in further crop improvement programmes like hybridisation or for selection.

References

Adeniji, O. T., 2018, Genetic variation and heritability for foliage yield and yield component traits in edible *Amaranthus cruentus* (L.) genotypes, *Bangladesh Journal of Agricultural Research*, **43** (3) : 513 - 524.

Aderibigbe, O. R., Ezekiel, O. O., Owolade, S. O., Korese, J. K., Sturm, B. and Hensel, O., 2022, Exploring the potentials of underutilized grain amaranth (*Amaranthus* spp.) along the value chain for food and nutrition security: A review. *Critical reviews in food science and nutrition*, **62** (3) : 656 - 669.

Anand, S. R., Niranjana Murthy and Prithviraj, S. K., 2020, Response of grain amaranth (*Amaranthus cruentus* L.) genotypes to different levels of fertilizers (NPK) under Eastern Dry Zone of Karnataka, *The Mysore J. Agric. Sci.,* **54** (1) : 60 - 64.

Blanca, M. J., Arnau, J., López-Montiel, D., Bono, R. and Bendayan, R., 2013, Skewness and kurtosis in real data samples. *Methodology*, **9** (2) : 78 - 84. https://doi.org/10.1027/1614-2241/a000057

Cain, M. K., Zhang, Z. and Yuan, K. H., 2017, Univariate and multivariate skewness and kurtosis for measuring nonnormality: Prevalence, influence and estimation. *Behavior research methods*, **49** : 1716 - 1735.

Choo, T. M. and Reinbergs, E.,1982, Analysis of skewness and kurtosis for detecting gene interaction in a double haploid population, *Crop Science*, **22** : 231 - 235.

Dhanalakshmi, T. N., Ramesh, S, Upadhyaya, H. D., Mohan Rao, A., Gangappa, E. and Priyadarshini, S. K., 2014, Genetic variability for morpho-agronomic traits in core germplasm collections of finger millet [*Eleusinecoracana* (L.) Gaertn.] based on third and fourth degree statistics and their origin, *International Journal of Tropical Agriculture,* **32** (1-2) : 239 - 242.

Dhangrah, V. K., Mandal, J. and Bhat, J. S., 2015, Heritable variation and predicted selection response of green yield and its component traits in vegetable amaranth, *Int. J. Bio-res. Env. Agril. Sci.*, **1** (4) : 146 - 152.

Federer, W. F.,1956, *Experimental design*, **81** (4) : 334. LWW.

Federer, W. T.,1961, Augmented designs with one-way elimination of heterogeneity, *Biometrics*, **17** : 447 - 473.

Fisher, F. A., Immer, F. R. and Tedin, O., 1932, The genetical interpretation of statistics of the third degree in the study of quantitative inheritance. *Genetics*, **17** : 107 - 124.

Groeneveld, R. A. and Meeden, G.,1984, Measuring skewness and kurtosis, *Journal of the Royal Statistical Society Series D: The Statistician*, **33** (4) : 391 - 399.

Kanavi, M. S. P., Somu, G., Marappa, N. and Koler, P., 2020, Studies on skewness and kurtosis of quantitative traits in green gram germplasm accessions [*Vigna radiata* (L.)] under drought condition, *Journal of Pharmacognosy and Phytochemistry*, **9** (2) : 501 - 509.

Kim, T. H. and White, H., 2004, On more robust estimation of skewness and kurtosis. *Finance Research Letters*, **1** (1) : 56 - 73.

Kotch, G. P., Ortiz, R. and Peloquim, S. J., 1992, Genetic analysis by use of potato haploid populations, *Genome*, **35** : 103 - 108.

Kumar, S., Meena, R. K., Yadav, S. and Meena,V. K., 2021, Genetic variability, heritability and genetic advance studies in Amaranthus(*Amaranthus tricolor* L.), *Annals of Plant and Soil Research*, **23** (1) : 77 - 81.

Kimbeng, C. A. and Bingham, E. T., 1998, Population improvement in Lucerne (*Medicago sativa* L.): components of inbreeding depression are different in original and improved populations. *Australian Journal of Experimental Agriculture*, **38** : 831 - 836.

Malaghan, S. N., Revanappa, S., Ajjappalavar, P. S., Nagaraja, M. S. and Raghavendra, S., 2018, Genetic variability, heritability and genetic advance in grain amaranth (*Amaranthus* spp.). *Int. J. Curr. Microbiol. App. Sci.,* **7** (7) :1485 - 1494.

Mokkaraj, J. and Geethanjali, S., 2016, Genetic diversity and variability in foxtail millet (*Setaria italica* L.) germplasm based on morphological traits. *Electronic Journal of Plant Breeding*, **7** (2) : 303 - 316.

Mardia, K. V.,1970, Measures of multivariate skewness and kurtosis with applications. *Biometrika*, **57** (3) : 519 - 530.

Niranjana Murthy and Arun Kumar, J. S., 2017, Grain amaranth (*Amaranthus* spp.) - An underutilized crop species for Nutritional Security and Climate Resilience, *The Mysore J. Agric. Sci.,* **51** (1) : 12 - 20.

Patil, H. E., Patel, B. K. and Patel, S. N., 2017. Assessment of genetic diversity in finger millet (*Eleusine coracana* L.) through multivariate analysis approach. *International Journal of Economic Plants*, **4** : 148 - 151.

Pooni, H. S., Jinks, J. L. and Cornish, M. A.,1977, The causes and consequences of non-normality in pretending the properties of recombinant inbred lines. *Heredity*, **38** : 329 - 338.

Robson, D. S.,1956, Application of K_4 statistics to genetic variance component analysis. *Biometrics,* **12** : 433 - 444.

Roy, D., 2000, Plant breeding - The analysis and exploitation of variability. Narosa Publishing House. New Delhi. India.

Sarker, U., Islam, M. S., Rabbani, M. G. and Oba, S., 2015, Variability, heritabilityand genetic association in vegetable Amaranth (*Amaranthus tricolor* L.), *Spanish Journal of Agricultural Research*, **13** (2) : 17.

Snedecor, G. W. and Cochran, W. G., 1994, Statistical methods. Fifth Edition. Iowa State University Press. Ames. Iowa, USA.

Vipin Kumar, Taru Dumi, Arvind Kumar, Archi Gupta and Uttam Kumar, 2020, Variability, heritability and genetic advance for yield and yield related traits in tomato (*Solanum lycopersicum*). *Annals of Horticulture*, **13** (1) : 61 - 65.

Yankanchi, P. P., Dhanalakshmi, T. N., Lakshmana, D., Shashidhara, N., Prakash, K. and Onkarappa, S., 2022, Studies on skewness and kurtosis of brinjal (*Solanum melongena* L.) germplasm for yield and its contributing traits. *International Journal of Bioresource Sciences*, **9** (2) : 111 - 114. DOI: 10.30954/2347-9655.02.2022.7.